# Measurements of Electromagnetic Radiation Pressure on Individual Dust Grains

Investigators: P.I.-Dr M.M. Abbas C.I. D. Tankosic Collaborators: Dr. J. Spann, Dr. P.Craven, E.West, R.Hoover

Dust grains in astrophysical environments experience a radiation pressure force due to the radiation from nearby sources. This force depends on the radiation intensity, projected surface area, and properties of the dust grains. Radiation and gravity determine the dynamical evolution and physical state of dust particles. The ratio of radiation pressure to gravity (β) on a particle is a useful quantity to evaluate the relative importance of radiation pressure in the dynamical evolution of dust particles. Particles with β greater than 1 experience an outward force and therefore move away from the source. The values of β for homogeneous spherical particles in the solar system maybe calculated using Mie scattering theory, if the real and complex refraction indices of the particle material are known. The facilities in the Dusty Plasma Laboratory permit direct measurements of radiation pressure on micron size dust grain and permit calculation of the radiation pressure efficiency. Clearly, radiation pressure plays a significant role in the dynamical behavior of submicron size dust grains as well as in the evolution and dynamics of interstellar clouds and intergalactic medium. 0

Laboratory Measurements of Radiation Pressure on Individual Particles
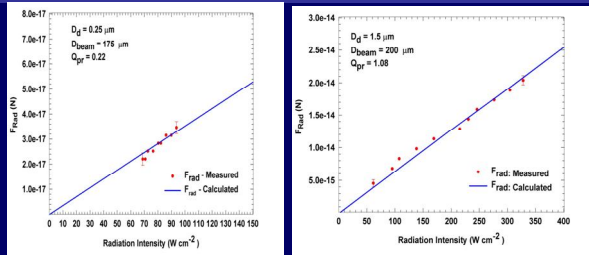

Radiation pressure measurements on individual Silica grains with diameters of 0.25 and 1.5 mm. The linear fits are for the indicated radiation pressure efficiencies

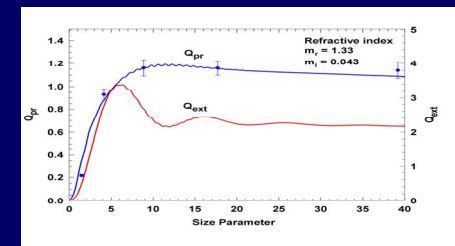## Laboratory Measurements of Radiation Pressure on Individual Particles (contd.)
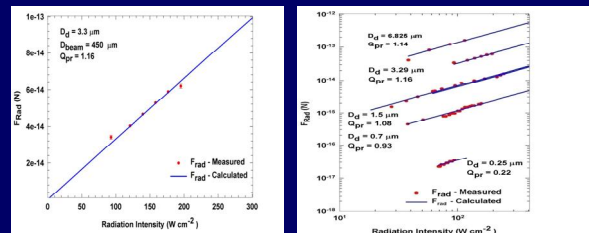
Radiation pressure measurements on individual Silica grains with diameters of 0.26 to 6.83 mm. The linear fits are for the indicated radiation pressure efficiencies

Comparison of Measured Radiation Pressure Efficiencies with Mie Theory
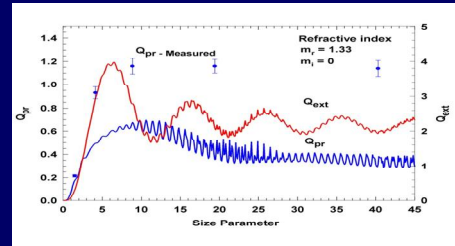
Plots of the radiation pressure and extinction efficiencies Q_{pr} and Q_{ext}, as a function of the size parameter $x = 2\pi r/\lambda$, for $m_r = 1.33$, and $m_i = 0$. The experimentally determined values of Q_{pr} for the silica particles are shown for comparison. The Mie theory resonance structure seen in this plot should be measurable by this technique for particles with high m_r but small m_i

Comparison of Measured Radiation Pressure Efficiencies with Mie Theory

(b) Same as in 3a.except with an inferred $m_i = 0.043$ to provide a least-squares fit to the Mie scattering theory calculations. The resonance structure for this case appears to have smoothed out.

Summary of Laboratory Radiation Pressure Measurements

Comparison of Mie scattering theory calculations of radiation pressure efficiencies of silica particles with the known value of $m_r = 1.33$, the experimentally determined value of $m_i = 0.0425$, and the measured radiation pressure efficiencies on the electrodynamic balance.

Particle Dia.(μm)	Size Parameter	Calculated Extinction Efficiency Qext	Calculated Scattering Efficiency Qsca	Calculated Radiation Pressure Efficiency Qpr	Measured Radiation Pressure Efficiency Qpr
0.25	1.47	0.33	0.16	0.28	0.22
0.70	4.10	2.75	2.12	0.94	0.93
1.50	8.80	2.66	1.66	1.21	1.12
3.29	19.35	2.36	1.24	1.18	1.16
6.82	40.12	2.17	1.11	1.09	1.14